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ABSTRACT

This booklet presents an interdisciplinary approach to environmental education. Part I concerns environmental study areas. Emphasis is placed on defining environmental study areas, site selection and program planning, and preparing to use the environmental study area. Part II presents instructional activities based on the "strand" approach. This approach consists of five strands or concepts of the environment: variety and similiarities, patterns, interaction and interdependence, continuity and change, evolution and adaptation. Instructional activities for each strand cover art, communications, mathematics, science, and social studies. Selected publications and films are included. (MJM)

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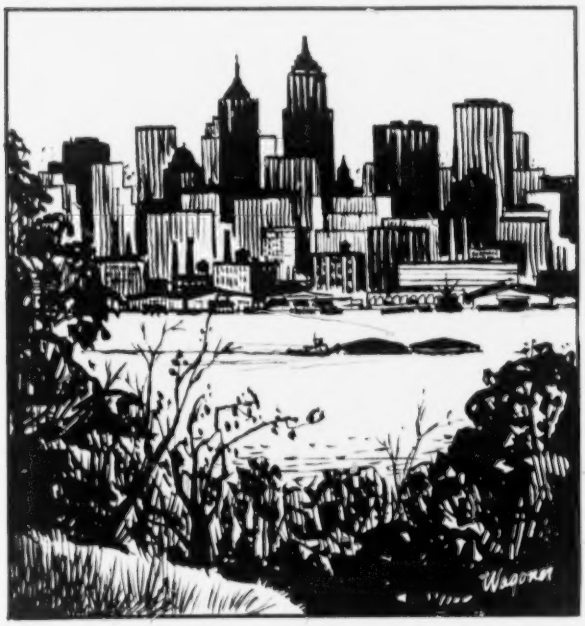

MAN AND HIS ENVIRONMENT

An Introduction To Using Environmental Study Areas

Association of Classroom Teachers
National Education Association
in cooperation with
Project Man's Environment
American Association for Health, Physical Education, and Recreation

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Association of Classroom Teachers
National Education Association

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Executive Secretary

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Sidney Dorros
Editor, "New Developments in Teaching" Series
Director, NEA Publications Division

Foreword

As the federal agency with the widest land management responsibilities, the Department of the Interior has taken the lead in making available its lands and facilities for establishment of areas dedicated to the study and understanding of our environment.

Not only the National Park System, which gave birth to the National Environmental Study Area (NESA) idea, but all Interior-managed lands now are dedicated to ecological awareness and education, wherever opportunity and citizen interest coincide. We hope and anticipate that the program eventually will spread far beyond Interior, taking on the complexion of the cultural and natural environment in which it takes hold.

The NESA program is an exciting endeavor, combining the Department's individual-oriented environmental materials with the resources of local educational communities.

This blend of efforts in interpreting the values and relationships between man and his cultural and natural worlds has worked splendidly within the National Park System. Now we are sharing it. We think it will stand on its own, wherever there is a piece of land, a teacher, and a child.

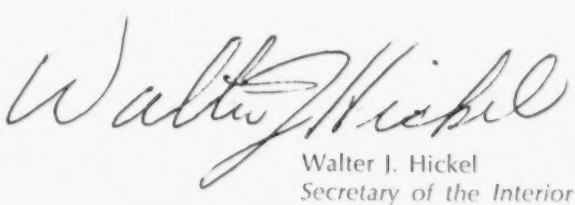
We fully expect that by offering this program to others, we will see the NESA concept take on added value and new dimensions.

Follow the environmental strands, and the sense of wonder shortly grows into a feeling of "belonging"—of being at home in the world, whatever part that may be.

As a teacher or resource person, the world you open up through these pages will be as big and meaningful and beckoning as your own daring, imagination, and enthusiasm lets it be.

Students will find the NESA to be a jumping off point, not a destination.

Students and teachers together will discover a beautifully complicated, much more wonderful world.



Walter J. Hickel
Secretary of the Interior

Of Men and Drums

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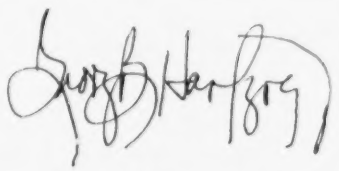
We are desperately in need today of help in relating ourselves to a world that seems increasingly shoddy—even downright dangerous to human life.

If man is a natural creature, why do we need this help? Possibly because we have lost track of our natural beginnings. Modern man is more a creature of his own civilization than of the natural biotic environment that, quite literally, grew him. We shaped a civilization and then, in turn, the culture of our own creation began to shape us. Most of our environmental woes today spring from "loss of touch" with the natural balances that still govern us, whether we realize it or not. Even man, with all his technology, cannot unbalance nature. If we put too heavy an entry into the pollution column, nature simply subtracts from the columns labeled "beauty" and "comfort" and eventually even "safety." The adjusted balance results in an unpleasant squeeze for most life forms that we humans consider desirable.

Our lives are inextricably interwoven into the thin blanket of life that covers our tiny planet. Let one thread rot or ravel, and the whole fabric is in danger of falling into disrepair or complete disintegration. Should such a tragedy occur, nature would eventually reach new balances. They might be of such a nature that man would no longer be a factor.

The National Park Service has established a network of environmental study areas where the superb natural and cultural values of the National Park System are interpreted through ongoing environmental education programs in nearby schools and for interested individuals or groups. These areas are for exploring, for discovering, for awareness, and for growth. In them, people can examine the natural pulses and rhythms of the Earth and its delicate, quivering balances. They can examine too the "different drummer" to which their own civilization marches.

Man is cunning, acquisitive, comfort-seeking, and infinitely inventive. If he can be jarred out of his preoccupation with his own uniquely human desires and his terrifying abilities to fulfill them, he may yet create a harmonious counterpoint of human and natural drums.



George B. Hartzog, Jr., Director
NATIONAL PARK SERVICE

Overview

Because man is the dominant organism on the earth and can, through technological manipulations of the environment, control much of its condition and consequence, man is the central figure in environmental education. Whether he is cloistered in a subterranean bunker of experimental laboratories at the South Pole, comfortably nestled in a penthouse in the midst of an urban setting, or thousands of miles out in space, the environment is a crucial and significant factor in determining the quality of his life. Environmental education ought to be a total look at where man lives, how he lives, and why he lives.

This booklet presents an interdisciplinary approach to environmental education. Environmental education is not a single subject; it is a synthesis of all school disciplines, understandings, and skills. Neither is it only the teaching of school subjects outdoors. The teacher uses the environment—natural or man-made, park or urban setting, historical landmark or scenic site—to help teach art, mathematics, science, social studies, or communication by helping the student to understand the relationships among these subjects, the environment, and man. Thus, the student may find he has learned something about ecology as well as about economics. Similarly, the teacher is likely to discover that any given subject, when related to the study of man's environment, inevitably leads to considerations of other subjects as the exploration widens

to include the total relationship of man to his environment.

This booklet is intended to help teachers expand their classrooms to include all of man's environment. Through the use of environmental study areas selected for their educational potential by teachers and resource management agencies, the study of regular subjects in the school curriculum can take on new dimensions. At the same time, students will discover some of the fascinating knowledge the environment can impart about man, his environment, and his relationship to it.

The approach to environmental education suggested in this booklet is through the use of five "strands" or concepts of the environment—Variety and Similarities, Patterns, Interaction and Interdependence, Continuity and Change, and Adaptation and Evolution. These concepts help the student see the relationships that exist throughout the universe. They can be applied to any subject area, and each application provides a different viewpoint of the environment. Through such an approach to environmental education and through the direct experiences and encounters with his social, physical, and cultural world that this approach provides, the student should gain understandings, attitudes, and skills inherent in the objectives listed on page 11. The ultimate goal is for the student to develop an awareness of his environment that will lead to a personal sense of involvement and to the shaping of an environmental ethic to guide his behavior.

Teachers and other persons interested in developing environmental education programs will find in this booklet a brief look at the background of environmental study area programs, suggestions for selecting sites and planning programs, aids to identifying the educational possibilities of a site and preparing lessons related to them, a detailed discussion of the strand approach to environmental education, sample class activities based on the strand approach, and references for additional help.

PART I

Environmental Study Areas

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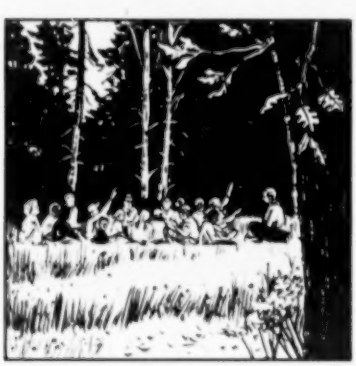

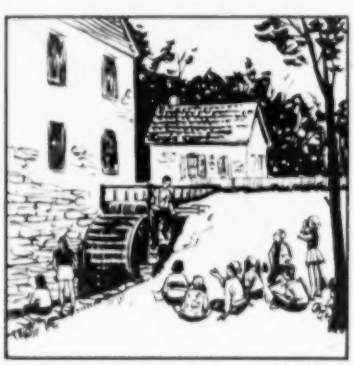

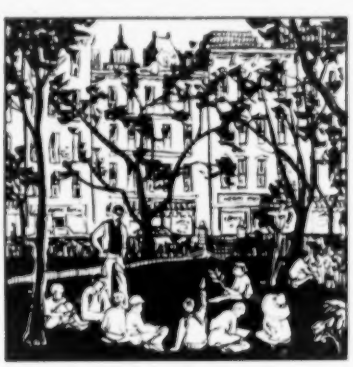

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What Is an Environmental Study Area?

Environmental study areas are intended to support and stimulate environmental education programs in local school districts. They can be used to teach students about man's relationship to his environment by examining man's interaction and interdependence with his surroundings through all disciplines in the school program. The conceptual—or strand—approach developed for environmental study areas and explained in depth in Part II of this booklet provides the student with new ways to perceive, appreciate, and evaluate his own environment, whatever it may be, however it may change.

Day trips to parks, to nature areas, to industrial and historical sites have long been an important part of the school experience. The National Park Service (NPS) of the U.S. Department of the Interior sought to expand such experiences by initiating the National Environmental Study Area Program. The NPS made available sites on Service-administered properties for use by student groups, calling these sites National Environmental Study Areas (NESA's).

A network of NESA's has been set up in National Park areas throughout the country. The NPS also provides guidance in the form of orientations and workshops for teachers using its sites. Similar programs which will utilize additional lands and other resources are being planned by other agencies within the Interior Department. Teachers themselves conduct the on-site classes developing their own programs or using prepared curriculum guides. The

teacher's use of this rich study resource is limited only by his enthusiasm, inventiveness, and ingenuity.

The National Park Service intended these NESA's to serve as models for the establishment of similar sites outside parklands in areas near participating schools. State or local park and conservation authorities, community organizations, industry, school systems, individual schools, and teachers can emulate the NPS program by creating their own environmental study areas.

In order to be selected as an environmental study area, a site should be rich in educational resources that help interpret the environment by illustrating biological or cultural relationships within the environment. Some environmental study areas may be primarily natural, located in areas of natural or scenic significance. They may contain examples of the elements, forces, and balances out of which man himself is made and out of which he spins his cities, society, and culture. Everything man is or builds is "nature" before it is anything else. Other environmental study areas may be primarily cultural or man-made—areas in which man has altered the environment to fit his particular needs. In such places, the student can learn to recognize how the environment has affected man's development and how man, in turn, has affected his environment.

As envisioned by the National Park Service, the principal objectives of an environmental study area program are—

- To introduce the student to his total cultural and natural environment, past and present, and help him realize that he is a part of it.
- To develop in the student an understanding of how man is using and misusing his resources.
- To provide an opportunity for the student to work directly with environmental problem solving.
- To equip the student to be a responsible member of the world that he is shaping and that is shaping him.

An environmental study area program may include a historical tour, a nature walk, or a visit to the city dump, but the most rewarding result of an environmental study area experience is something that places the individual and his own culture into an environmental perspective. The emphasis on environmental awareness should synthesize fragments of learning about man and his environment into a whole.

12 Site Selection and Program Planning

Ideally, educators and resource managers (persons who administer lands, facilities, and other types of resources) should work cooperatively to select and plan the use of a site as an environmental study area. Teachers who select sites to use as environmental study areas should consult with the resource manager of the site and enlist his aid and expertise, just as resource managers should seek the cooperation of teachers and administrators in developing the sites under their administration for environmental education.

Whether the environmental study area is a site provided by the National Park Service, a similar location sponsored by a state historical society or local park authority, or an area selected by school personnel, it should have certain characteristics that make it a suitable study area. For example, the site should—

- Have specific educational possibilities.
- Contain elements that illustrate the effects of human activity.
- Be easily accessible to students.
- Have such facilities as parking areas, drinking fountains, and rest rooms.
- Be resistant to repeated use by groups of students.

Program planning for an environmental study area can be a rather elaborate procedure (see Fig-

ure 1, "Procedural Steps in Developing an Environmental Study Area Program"). It may, for example, begin with the selection of a site by a resource manager, such as a National Park Service official, who then calls in educators and local environmental experts to form a planning committee (see Figure 2, "Suggested Planning Committee for an Environmental Study Area Program"). A preliminary survey team may set down in a general manner the characteristics that are educationally pertinent. Later, this outline can serve as a basis for discussion among educators who will design a program of environmental education and plan more fully for relating subject areas to the site. Over the course of many months, environmental education is woven into the curriculum of the school system, teaching materials are prepared, in-service workshops in environmental education are conducted for teachers, the site is tested with trial groups of students, and a handbook for the site is produced.

Whether the most complex and complete planning is involved or whether a single teacher develops for his class a course of environmental education in an area that he has identified, the ultimate success of any environmental study area program rests with the teacher and how effectively he is able to guide and motivate his students to understand the relationship between man and his environment. The teacher should become familiar with the principles of environmental study area programs and the strand approach to environmental education. He should also visit the site before preparing on-site lessons for his classes. Whatever the type of site used, the teacher should inquire about instructional materials that might be available from the resource manager and about other assistance, such as workshops or orientation seminars, which might already be available or else might be developed cooperatively with personnel at the site.

Examining the site and participating in in-service programs in environmental education will enable the teacher to decide (a) how the educational possibilities of the site apply to his own classroom situation; (b) how to guide the students to a conceptual understanding of the ecology of the site through the strand approach; (c) how on-site information can be related to the students' own home environment; (d) what choice of subject matter will best show the constructive and destructive relationships of man to the environment; and (e) what aspects of the site can help make environmental studies a motivating as well as an instructional experience.

Figure 1

Procedural Steps in Developing an Environmental Study Area Program

1. Survey the locale to identify prospective environmental study areas. Determine conditions and limitations for use of each site for educational purposes.

2. Contact resource managers and/or teachers who may be possible users of the site, explain the reasons for providing a site for environmental studies, and solicit cooperation in developing an environmental study area program.

3. Schedule a conference for representatives of interested schools, resource personnel, and community members to explain the environmental study area program.

4. Form an advisory committee of educators, resource management personnel, and others who can help develop the most educationally suitable site(s).

5. Aid the advisory committee in preparing instructional materials using pre-site, on-site, and post-site formats.

6. Prepare a handbook for those who will use the site. The handbook should cover practical considerations in using the site and discuss the educational characteristics of the site from the viewpoint of the strand approach.

7. Hold workshops and on-site visits to acquaint resource personnel and teachers with the physical characteristics of the site and its educational possibilities.

8. Select several test classes to try out the instructional materials.

9. Evaluate the results and adjust the environmental study area program. In making the evaluation, the following questions should be asked:

   Were the logistical plans satisfactory?

   Were the conditions for use, as identified in advance, adhered to by the users?

   Was the handbook adequate?

   How did the students respond to the experience?

   What were the teachers' reactions to the experience?

Figure 2

Suggested Planning Committee for an Environmental Study Area Program

A planning committee to develop an environmental study area program might include the following persons:

- Resource management personnel
- Curriculum coordinator for a local school system
- Curriculum consultants from individual schools, particularly those specializing in such areas as outdoor education, social studies, or science
- Classroom teachers who are interested in participating in the project
- Representatives of the local education association
- Local professors of education who are interested in environmental education (and who may also assign graduate students to help with the project as part of their training)
- Professors conducting research programs related to the environment
- Representatives of community agencies and organizations concerned with conservation, history, and local action
- Local officials from federal or state agencies that have programs related to environmental education (e.g., departments of agriculture, forestry, wildlife, water resources).

All persons participating in the development of the program should meet at the site as part of the survey and feasibility study. They should examine the site and offer suggestions based on their particular areas of competence. Such firsthand observations should be invaluable in planning how best to use the resources.

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Preparing To Use the Environmental Study Area

Analyzing the Site

To develop programs that make the best use of an environmental study area, the teacher must become familiar with the educational possibilities of the site and the practical considerations involved in using the site for educational activities. A program of environmental education that results in a broad understanding of the relationship between man and his environment requires the teacher to do more than simply teach art or mathematics or history at an outdoor location. He must know certain facts about the site that involve man's total relationship to his environment. He must then be able to relate the subject matter he will teach at the site to people and to vital social, political, or economic concerns of the day.

First, the teacher must become acquainted with the descriptive features of the area and with its historical significance. But he must go beyond merely identifying the flora and fauna or the outstanding physical features of the facility. He must take a close, analytical look around the site and decide which of its characteristics are relevant to people and environmental education in terms of his subject or discipline.

The John Muir Home in Martinez, California, can serve as an example. This historical landmark—the home of a naturalist, explorer, and writer—located in a semi-agricultural, semi-industrial county seat lends itself equally well to the study

of economics or behavioral sciences. Since the site is located near a beautiful creekside area, its natural history is an important characteristic that is of interest to science as well as art classes. Surrounding environmental concerns that can be related in some way to any subject area include problems of pollution and diminishing natural beauty.

Every environmental study area program should be built upon awareness of the environment, its glories, and the dangers threatening it—misuse by visitors, threatened encroachment by developers, water or air pollution from nearby industry or towns. Every school subject can be used to observe, analyze, and attack environmental problems. Exposing students to such problems can be the beginning of a solution. Once initial awareness is engendered, the environmental study area program can begin to move toward the environmental solutions inherent in its interdisciplinary, strand approach.

Teachers who will use the site after it has been developed for use as an environmental study area can be spared the repetitive task of analyzing the site anew if the educators and resource managers involved in the initial planning prepare a handbook for the site. The handbook should include pertinent general information gathered from an analysis of the specific site and should discuss the educational possibilities and environmental relationships and problems illustrated at the site, suggested learning activities using the strand approach and based on the site's particular characteristics, and practical considerations involved in using the site as an environmental study area.

Each teacher, however, should visit the site before developing learning activities for his own classes in his own subject areas. No handbook can replace the teacher's intimate knowledge of his classroom situation and the needs of his students.

Developing Learning Activities

Learning activities that make the best use of an environmental study area should be student-centered and oriented toward highly motivational learning. Each lesson should introduce a problem, suggest methods of attack using the school disciplines, and explore possible solutions. Emphasis should be on creative thinking and productive activity.

For example, an important statistic about the facility may produce an interesting mathematical problem, or the area may lend itself to a population survey. A story associated with the site may lead students to some study of sociology, history, or geography. Perhaps high school students can apply at the site skills derived from chemistry, physics, or biology. Many sites have particularly beautiful views or aesthetic impacts that inspire artistic interpretation. The area may motivate students to consider different forms of literature or engage in a writing activity of some kind.

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Pre-site activities should introduce new and exciting learning opportunities. The on-site experiences should encourage students to continue their investigations in the classroom. Post-site lessons and projects based on student interest should further stimulate each student to develop a richer sense of his relationship to the environment.

In studying the environment, no one subject stands alone. Traditional educational methods of fragmenting knowledge into subject areas are somewhat artificial. While instruction at a "natural history type" site could easily tend toward the biological or general scientific areas, and while the study of natural sciences is certainly not to be discouraged, environmental education should encompass many subject areas. The students might use elements of math or science to find their way to a particular spot by transit, compass, or trail maps. At the site, one group might be concerned with the artistic and aesthetic aspects of water, soil, and rock interaction in a stream bed; another might create a topographic map of the area for later use in selecting a campsite for the class. A third group might reconstruct the history of man on the site by geological observation of the area with help from on-site personnel. A fourth group might discover nature's manner of communicating through an intriguing session on sensory awareness. When the arts are studied through the environment, thoughts should range concurrently through the technological, the mathematical, and the historical realities of any given area.

The John Muir Home again provides a case in point. While looking across the beautiful golden hills of California, one cannot avoid observing the oil refining tanks that intrude upon the view; the freeways and railroads that cut into the land; the power lines that stretch in all directions. Whatever a student in an English class might write concerning the area would, perforce, consider these observations; whatever a student might measure in a mathematics class would necessarily reveal the artistic and aesthetic impact of the geometric patterns; whatever a student might organize into statistics would have to underscore related trends in economics, politics, sociology, and certainly geography and history.

The teacher should formulate probing questions to stimulate his students to think about the environmental problems of the site before, during, and after the visit. The questions should be geared to the different groups of students using the area. Age levels and differences in school curriculums should be considered. In the lower grades, the questions can be related to the way one can learn about and appreciate his surroundings. The focus can be on appreciation of the beauty of the area, knowledge about the site, skills that can be developed by use of the area, and ultimately ethics and attitudes toward the environment. Pupils can develop awareness of the environment through an exploration

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of the interactions and interrelationships in the environment.

At higher school levels there should be more stress on technical approaches and environmental problem solving. For example, junior high school students usually have had enough science and math to be able to answer interesting questions about the composition, quantities, and relationships of various objects, which can lead to an understanding of man's use and misuse of his environment.

High school students may be most interested in analyzing the site from the viewpoint of the social sciences. Senior high school students can study how man must govern his resources in order to use them intelligently, maintain the balance of nature, and manifest a feeling of responsibility for the environment. These older students are close to becoming environmental decision makers—the voters of the future. Their concern for an ethic derived from environmental values should be encouraged by questions that probe their environmental conscience. For example, what should be done at the John Muir Home area to curtail the air pollution caused by local oil refineries? Are the students willing to pay for higher oil costs if refineries are forced to change production methods?

Examples of questions for student discussion that relate to specific environmental study areas appear in Part II of this booklet.

Practical Considerations

Besides the educational considerations already discussed, the teacher must deal with several very practical problems if he is to use the site effectively with students. He must think about logistics: where the site is, how to get there, what the surrounding area is like, when the best times for travel are.

The teacher will need to know about the site's characteristics in preparing for the visit: what comprises the site, what can be expected at different times of the year, how best to take advantage of the special features the site offers, what facilities are available. Some groups will come to the site for a day, others for a week; some will observe quickly, others will want to study minutely. Will it help to have rain gear, climbing boots, waterproof sleeping bags, binoculars for bird watching? What kind of equipment is appropriate to the activities students will most likely pursue at the site?

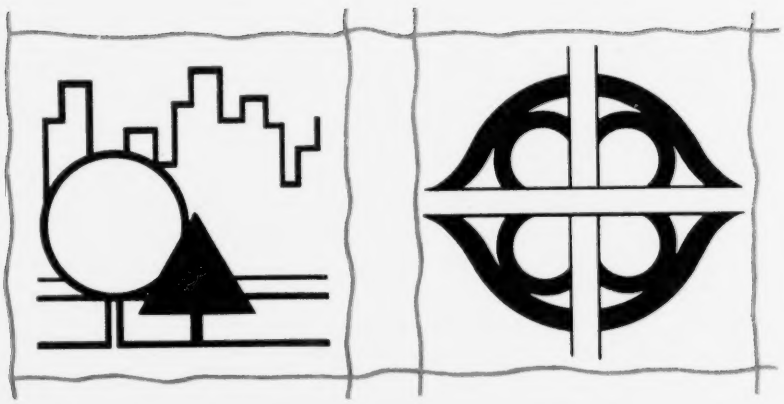
The teacher who is new to conducting classes at environmental study areas should understand that the less equipment brought to the site the better. Collecting on the site is done only by special permission and is generally discouraged; therefore, bottles, nets, traps, or other cumbersome (and often dangerous) paraphernalia should be left at home. Students saddled with the responsibility of comprehensive notetaking or with long checklists of things to observe are often so busy recording and searching

for specifics that they rarely get the big environmental picture.

Reference materials to aid in identification are handy, but not so essential that the expedition be weighed down with them. The on-site experience should be primarily observational, leaving the research, calculations, and more academic studies for post-site lessons back in the classroom. Work best accomplished in the classroom should not be attempted at the environmental study area.

The best guides to what to take along are the activities most suited to the site and the subjects to be studied there. For example, if the field trip to the site is to concentrate on mathematics, prearranged worksheets—simple in design—should serve as guides for taking a population census or measurements. If the on-site experience is to include identifications of objects, the pre-site studies should include enough information so that the students know what to look for. If, on the other hand, the on-site experience is to allow the students the excitement of making discoveries, there should be enough guidance—in the form of pertinent questions—to direct their observations toward given goals. When the environment is to be used as a vehicle for discussion, as in a social science field study, there should be a predetermined understanding of what environmental on-site observations will best motivate the students. A research trip, though open-ended and allowing students a great deal of freedom, should have specific learning objectives.

These preliminary considerations—selecting a site, identifying its educational possibilities, developing it for student use, planning a program of environmental education, and preparing learning activities—are essential to an effective environmental study area program. When carefully undertaken, they pave the way for the teacher to embark with his students upon the fascinating and rewarding study of man and his environment.



PART II

Instructional Activities

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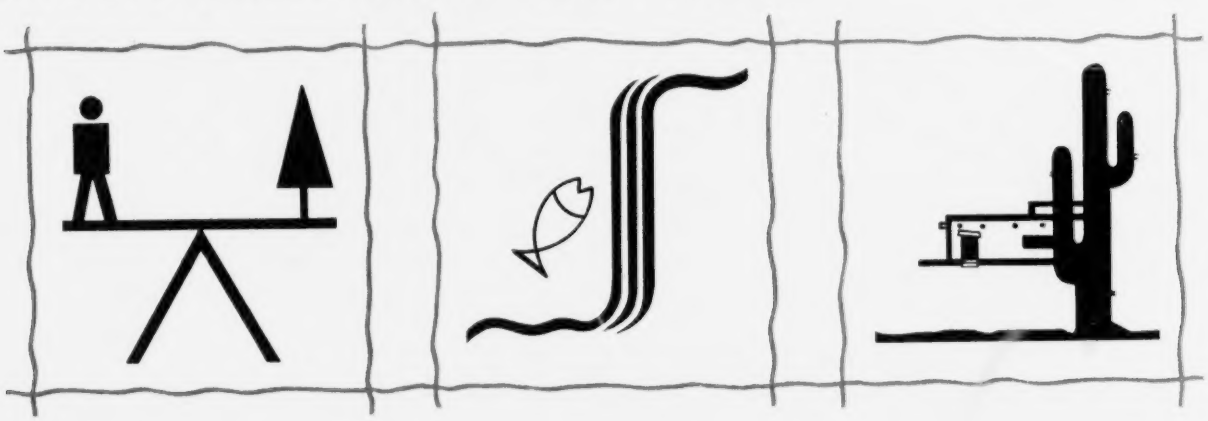

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The Strand Approach To Environmental Education

There are many productive ways in which to make use of the environment as an educational vehicle. One approach is strictly taxonomical: everything has a name and a specific way of interacting with the universe. Scientists describing unique objects use the taxonomical method as a principal operational procedure in their investigations. This method, however, has a drawback for the teacher with a limited scientific background, who may not know the multitude of specific names and conditions with which to describe the environment scientifically.

Another way of approaching environmental study is through an investigative, completely open-ended method. The teacher guides the student in his attempts to discover what is present in his surroundings and to place his discoveries into some kind of perspective. The advantage of this method is that it provides the kind of study that activates sensory awareness and enables the student to develop creative problem-solving techniques. The difficulty rests with the development of research skills. Research skills are another tool of the scientific investigator, and although they would provide a good background in problem solving for the student, it takes time to develop them.

The strand approach draws upon the advantages of both of these methods while eliminating the disadvantages. It incorporates both the specific and the investigative approaches into a third approach with which both student and teacher can feel more

comfortable. It requires identification and classification, but on a modified basis. It also requires open-ended investigation leading to problem solving. Yet all of its requirements can be taught by a teacher and fulfilled by a student who has little of the rigorous scientific training demanded by the other approaches.

The strand approach makes necessary a reorganization of thinking into unfamiliar patterns, which may at first be difficult. The valuable, unifying characteristic of the strand approach, however, makes whatever initial effort may be necessary unquestionably worthwhile.

The Strands

The strand approach uses five broad, universal concepts as a way of drawing the environment under a total, integrated "umbrella." These concepts or strands are five:

Variety and Similarities

Patterns

Interaction and Interdependence

Continuity and Change

Evolution and Adaptation.

Variety and Similarities. Many likenesses and differences occur among living and nonliving things. A variety of functions, sizes, and structures exist in plants and stars, rocks and animals, processes and people. Yet there are sufficient similarities to permit their classification into orderly patterns. These classifications increase one's understanding of his world.

Patterns. Organizational patterns are kinds of structures that may be found in rock formations as well as in social groups of people and animals. Functional patterns include traffic movements and classroom schedules. Spatial arrangements are patterns that often please us. Such patterns occur both in nature and in artistic design.

Interaction and Interdependence. Nothing exists in isolation. Each individual is constantly interacting with living and nonliving things: his family, his belongings, his friends, his world. These people and things also depend on the individual in order to function properly. The process is continuous (as

part of the life cycle) even after death, for dead life forms nourish the living.

Continuity and Change. Both living and nonliving things are constantly changing—whether among galaxies and planets or within body cells and body systems. Some things remain the same in spite of change. Matter and energy may change in form, but they can never be created or destroyed.

Evolution and Adaptation. Over centuries and centuries of time, living and nonliving things alter and develop in the process called evolution. Probably the greatest number of changes over the longest periods of time come about in order to enable an organism to adapt to the environment. Hereditary factors then preserve the continuing elements. The characteristics that enable the organism to adapt best (for example, the best food-finder) are apt to be the traits passed on from generation to generation, thus ensuring survival of the species.

Variety and Similarities means the simple recognition of each organic and inorganic thing. A classification is derived by noting similar characteristics in distinct objects. Once a classification is made an object's *Patterns* can be identified. What is the nature of its design? Of its function (what does it do)? Of its organization? The functional pattern leads directly to *Interaction and Interdependence*. How does the specific variety interact with air, water, earth, (other) populations? As the variety interacts, it is subject to *Continuity and Change*. Anything that exists is subject to the constant change that every organic and inorganic substance is undergoing as a result of interaction with air, water, earth, and (other) populations. As it continues to change, it is constantly undergoing *Evolution and Adaptation*, according to how it fits into the pattern of existence. If a substance does not adapt in its present form, it evolves, through Continuity and Change, into a new Variety, with a new Pattern of Interaction and Interdependence.

Using these large concepts, or strands, teachers who have had no particular scientific or ecological training can instruct or guide students toward open-ended, purposeful activities. The scope of the strands can be focused on the specific at almost any level of detail or sophistication. Within the strands there is a synthesis of environmental relationships. This synthesis makes the strands applicable to the wide range of disciplines within the school program, yet the strands provide a vehicle for study that can be specifically related to the most widely differing ecological situations. For example, Patterns can be applied to the arrangements of beach fauna (biology), mountain ecology (natural history), or people living in an urban area (social sciences).

The next section provides an outline of ideas, questions, and lesson suggestions that can be used to teach environmental education through the strand approach. The strands are explained in ways teachers

might use to introduce them to students. Each discipline (art, communication, mathematics, science, and social studies) is then related to each strand, with specific examples of how strands and discipline work together and specific lesson suggestions. Since the many different environments cannot be covered in this booklet, the questions and lesson suggestions are designed to assist the teacher in determining the most cogent points to be discussed with the students. The teacher should expand these lessons to include items that apply to the particular site he is using.

The teacher should think of himself as a catalyst—permitting the students to develop the answers themselves whenever possible, which will result in a greater retention of the basic understandings. Once the basic strand understandings are established with the students, they will continue to seek new examples in new environments, leading to a keen awareness of man's interactions with his world.

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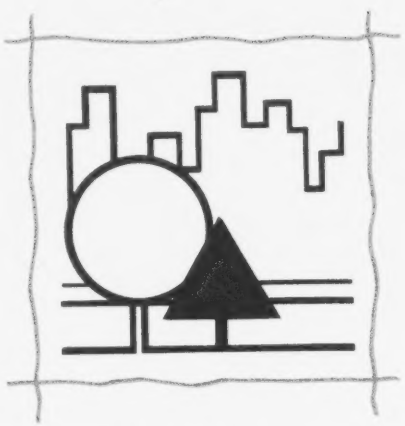
26 Sample Learning Activities Using the Strand Approach

This section is designed to guide the teacher in adapting his particular curriculum to the site he will be using. Each strand is presented in terms that will enable the students to look at their world and all the things it contains from the viewpoint of the five concepts of the strand approach. Students who have never before thought about the environment in terms of the unifying concepts of the strands will need to readjust their thinking in order to use this approach successfully. Teachers can adapt the definitions, ideas, and points for discussion to any age or grade level.

For each strand there are questions for students and suggestions for teachers for pre-site, on-site, and post-site activities involving the various subject areas.

Every environmental study area will have its own special characteristics and its own educational possibilities. For some, resource managers will have prepared lesson guides or other material that will further assist the teacher in planning stimulating educational experiences. The teacher will need to draw together all of the available information and select what is most suitable for his subject area, classroom situation, and age level and interests of his students in order to create his own relevant course in environmental education.



VARIETY & SIMILARITIES

Introducing Variety and Similarities to Students

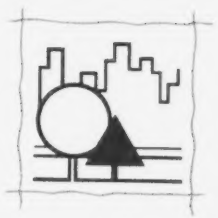
Variety can be found in different kinds of things in the same category or class. The universe contains many different kinds of objects—some huge, like giant stars; some very small, like microscopic bacteria. Objects can vary in many ways—in color, shape, texture, or the way they are used. But each unique variety has a number of similarities by which you can recognize that it belongs to a certain group.

A simple way to separate varieties of things is to classify them as animal, vegetable, or mineral. For example, think of a lizard, a deer, a cat, a desk, a lion, a dog, and a chair. How many varieties of things can you find in this group? Are there any similarities?

Variety is the spice of life. It would be strange if everyone looked exactly alike. You wouldn't be able to tell your friends from strangers. Yet though each of us looks different, we all have similarities. Everyone has eyes, a nose, hair, arms, legs, and other features that put us into the group of Man.

There is variety in everything, indoors and outdoors. But you will find that everything you look at also has similarities to another group. You can always put a "new" thing into its own family, or into the variety of family to which it belongs. All trees are trees and all flowers are flowers, but they do not all look the same or smell the same or function the same way.

You can recognize a variety by checking on the similarities. How is this object the same as others? To what group does it belong? How is it different from others in the same group?



ART

Lesson Suggestions

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At the site, the student can see the environment in new ways through the focus of different art forms. Asked to interpret what he sees in a creative way and according to his choice of art media, the student will come up with his own insights and feelings about the site, which may never have been brought out through a scientific or mathematical analysis of the environment.

After identifying objects at the site through an analysis of their variety and similarities, students might render the objects in various graphic forms in such a way as to emphasize their variety and similarities.

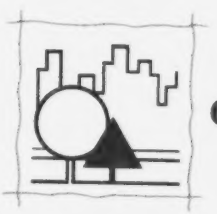
Students can then observe the great variety of ways their classmates interpret the same environment. Perhaps in pre- and post-site lessons students can study what some great artists have done with similar environments in various art media.

Questions for Student Discussion

Art focuses upon the environment. What on-site discoveries can you make of subjects that would lend themselves to painting, song, dance, or other artistic interpretations?

What might be revealed about the area with a variety of on-site photographs made into a collage?

What similar elements of this site would recur in a variety of artistic representations of it?



COMMUNICATIONS

Lesson Suggestions

The pre-site lesson might center on the many different kinds of communication—animal and human nonverbal communication; human languages, oral and written; and the great variety of invented languages (deaf-and-dumb sign languages, espionage codes, etc.). How are these varieties of communications similar? Why do we need to communicate? How does our environment communicate with us?

The on-site lesson can be a look-and-listen research project, directing the students' attention to the many kinds of communication that are transpiring at the site. These should be nonverbal as well as verbal, animal as well as human, from nonliving as well as living objects.

The post-site lesson back in the classroom can explore the many factors that hinder good communication.

Questions for Student Discussion

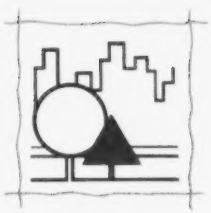
How many ways can one pick up environmental communications (seeing, hearing, touching, smelling, tasting)?

How many different feelings do the physical perceptions of the environment convey to the aware observer (pleasure, joy, thoughtfulness, fear, hope)?

How many different sounds can be heard on the site? How are they alike? How are they different? How can they be identified? What emotions do they suggest?

Do inanimate (vegetable and mineral) objects in the environment communicate with us? How?

What danger signals can you read from the environment which tell you the land has been misused?



MATHEMATICS

Lesson Suggestions

Objects in the environment are many and diverse. Mathematics from the simple elementary school level to the sophisticated college level was created largely to keep count of the various objects in the universe—to measure them and describe them in the language of numbers.

A lesson or several lessons that teach students to recognize what, how many of what, and the size of the what's can result in a challenging and realistic relationship with the environment. For example, a lesson that asks the student to count the different kinds of plant life he sees and to arrange them into sets of similarities not only will sharpen the student's appreciation of plant life, but also will clarify for him a basic and highly useful math skill.

Eventually, objects perceived in number language will help the student relate what he counts to the total environment, to all the interactions of his surroundings.

Questions for Student Discussion

How many different things can be counted at this site?

How many are there in each set?

How many sets intersect (have similar parts)?

How many equivalent sets are there?

How many equal sets are there?

How many disjoint sets are there?

Can methods of counting environmental objects change the count?

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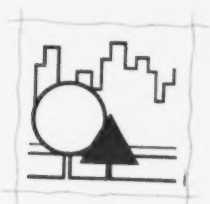
Why is it critical to count things in the environment?

How can you make population counts?



SCIENCE

Lesson Suggestions

In the pre-site lesson, students might consider the diversity of objects found in the environment, including matter as seemingly disparate as the human animal and a tiny marble.

In the on-site lesson, the students can focus upon the infinite variety found in nature and, at the same time, upon the similarities that allow certain objects sharing common characteristics to be categorized as either animal, vegetable, or mineral. The tiny marble referred to in the classroom might be seen at the site as an enormous slab in a rock formation, illustrating how substances with similar scientific properties may appear in a variety of forms.

The object hunt (similar to a treasure hunt) is a good introduction to the on-site program.

The post-site lesson can deal with the many factors—such as weather and other natural phenomena—that influence the objects in a given environment, as well as with the basic scientific laws that govern all of these functions.

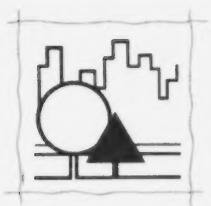
Questions for Student Discussion

How many varieties of objects can be identified on the site? How are they similar to each other? How are they different from each other?

What scientific laws can be readily illustrated?

How many different kinds of populations are here? How are they alike? How are they different?

How many of the things that you observe here can also be seen in your home environment?



SOCIAL STUDIES

Lesson Suggestions

The pre-site lesson can introduce the student to the study of a variety of populations, human and animal. He can analyze the ways in which these groups are similar in their functioning, i.e., mutual protecting, food-gathering, child-rearing, etc.

The on-site experience can direct the student's attention to living populations present at the site. These should include insect, bird, and mammal groups.

VARIETY & SIMILARITIES

The post-site lesson can scan the various social groups that have an interest or have played a part in setting up the site itself. All of these social and political groups, of course, share a common goal in relation to the site.

Questions for Student Discussion

Every area has a geographical history. What is the geographical history of this area? Was this area habitable by people? What other kinds of populations were here? Are they still here? Are there new populations? Changed populations?

How many things on this site are valuable to man?

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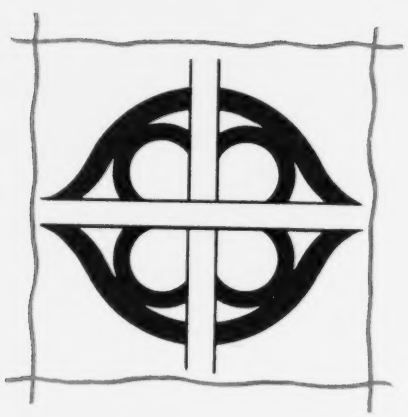


PATTERNS

Introducing Patterns to Students

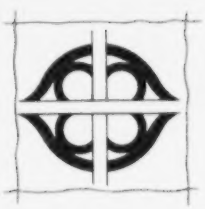
Patterns are spatial, as in design; functional, as in use; organizational, as in a grouping. Patterns imply a repetition—of an effective design or use or grouping. Patterns are the infinite order of things.

There is a pattern in the stars and stripes of the flag, in a starflower or an ivy leaf, in the markings on a zebra and on a striped shirt. There are organizational patterns in clubs, societies, and countries. There are functional patterns in the way people, animals, and plants live together. There are spatial patterns in the constellations in the sky. The ancient Greeks saw designs in the stars and told stories about the people and animals who inhabited the skies. What kinds of patterns are exemplified by a starfish? a pine cone? a zebra? the Milky Way? a beehive? a highway? a family? the city council? a wolf pack? a marching band?

Rocks on the shore of a lake or in the ocean or on the hills come in patterns from pebbles, which a sand crab or spider can use for his home, to groups of boulders that are homes for cougars in the United States and tigers in Asia. The variety of patterns producing homes affects the variety of patterns of life inhabiting these homes.

There is a pattern to our existence and an order of things that fit together like a well-thought-out puzzle. Trees are just the right structure for making shade. The pattern of leaves on branches is right for catching the sun's light and for blossoms.

A good or useful or pleasing pattern can be destroyed if one element in it changes. Sometimes a new and better pattern will form; sometimes not. If we were all giants, we wouldn't be able to sit under the trees for shade; they would be like little bushes. We would need a whole acre of corn to eat instead of just one ear. There wouldn't be enough food for everyone, and our whole pattern of life would be different.



ART

Lesson Suggestions

The pre-site lesson can examine patterns in art works that used the environment as subject matter.

On the site the student can see natural patterns in functional operation and can realize more fully how they influence the patterns of art.

The use of musical patterns as background to an on-site experience could produce an aesthetic experience beyond the capability of the classroom.

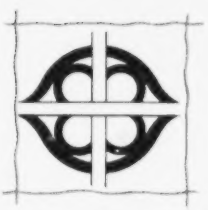
In the post-site lesson, the student might consider how patterns of design can be used in tomorrow's environment. He thereby not only learns to appreciate the natural world more fully, but also learns design principles basic to all of man's creations.

Questions for Student Discussion

Patterns in the environment are also patterns of art—circles, ovals, squares, triangles, stars, spirals, crescents. How many of these can be identified at the site?

How could patterns of leaves, flowers, and plants be arranged to indicate the seasons of the year?

What similar environmental patterns both on the site and in your home or school surroundings have been rendered in art?



COMMUNICATIONS

Lesson Suggestions

Patterns render a sense of order and comprehensibility to our world. Languages are made intelligible by the many intricate patterns that are built into them. What are these language patterns? There are grammatical patterns, of course, but there are other patterns too, such as the diaphonal nature of dialects or the battery of rhetorical devices.

At the site, students can analyze the patterns they observe in animal and human communication. For instance, can they see differences in the patterns of animal communication (bird calls, the antenna-

touching of ants, the dances of bees, etc.)? Are there patterns in the different kinds of human communication (lectures, friendly exchanges, commands, etc.)?

Back in the classroom, the students might discover how patterns in the environment can affect patterns of communication. For example, try out various seating arrangements—even very unusual ones, such as a wide circle with everyone's back to the center—and observe how these patterns change the content and feelings of the communications exchanged. Put a student "in Coventry" (all refuse to talk to him) and observe how the patterns of communication change.

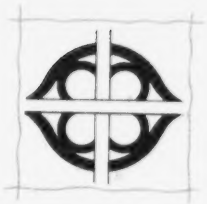
Questions for Student Discussion

From the land formation, evidence of habitation, cloud patterns, and use of the land, what does the site "communicate" about its past, present, and future?

How have environmental factors influenced or even dictated certain patterns of communication?

Man's modern existence necessitates a complex pattern of communication. How did patterns of communication figure in the on-site trip?

What animal communication patterns are recognizable on the site?



MATHEMATICS

Lesson Suggestions

Statistics are actually numbers arranged in patterns. Lessons in number arrangements can help the student describe his world in terms of averages, medians, and stanines. Such lessons can show him how to group objects into certain number relationships that show trends (what is happening to his environment, for example) or reveal what objects should or should not be present in his surroundings and in what quantities.

In a pre- or post-site lesson, the student can describe what he learns about the environment from statistical reports in newspapers or from data and counts of student characteristics made right in the classroom. Either way he can get firsthand knowledge about his own surroundings by treating numbers of things in patterns as they relate to the total environment.

Questions for Student Discussion

From a plant and animal count at the site, can

you clarify how different topographies in the same area affect plant and animal population groupings?

What kind of statistical expressions can show survival patterns of plants or animals?

Is the number of rocks essential to the total environmental pattern?

How can statistical evidence clarify the effects of overpopulation on air, water, and earth?

SCIENCE

Lesson Suggestions

On the site, the student might concentrate on the patterns he sees (or otherwise senses) in and among the objects around him. Are the patterns spatial (an interesting crystal formation), organizational (a colony of bees), or functional (a team of National Park Service personnel building a campsite)?

The student can try to identify ways in which the patterns he sees are determined by certain environmental factors, e.g., a cluster of trees with their trunks all bending the same way because of constant exposure to wind from a given direction.

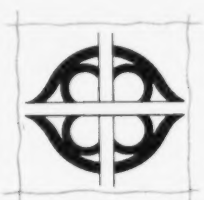
Questions for Student Discussion

What are the patterns that help to classify objects on the site?

What is the design of each object? What is the function of each object?

What are the topographical patterns of the area?

How does the pattern of the food-chain cycle work at this site? How does it compare with man's food-chain store?



SOCIAL STUDIES

Lesson Suggestions

In the pre-site lesson, the student can consider the patterns of the groups to which he belongs. Some groups, such as the family, have served important functions. Others are more specialized and

specific, such as church congregations or political parties.

What are the patterns of the groups observed on the site? A column of ants can illustrate work groups, and nesting birds can show the patterns of family groupings.

In the post-site lesson, the student might probe aspects of populations other than function, such as groups determined by age, by sex, or by formal as compared to informal organizational structure.

Questions for Student Discussion

How does the environmental pattern affect the way people live? What are the major industries in the immediate area? How do these industries affect the water? air? land? What resources do they depend on? What natural resources are used for recreation?

Is the population pattern affected by the environmental pattern? Why do people migrate to this area? Why do people emigrate from this area? How do the population patterns affect the environmental pattern?

How does this area fit into the overall pattern of the nation?

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INTERACTION & INTERDEPENDENCE

Introducing Interaction and Interdependence to Students

Interaction means to act upon one another. In each of the following situations, think about how one form of life acts upon another:

A cobra and a mongoose fight, each struggling for its life.

The sunflower lifts its face to the rain and drinks gratefully.

The moss takes root in the rock and begins the ageless process of grinding it into soil.

A crocodile opens its jaws for the plover, who methodically begins cleaning food from the croc's jagged teeth.

Interdependence means to need and rely upon others. It is, of course, a special way of looking at interaction. It emphasizes the way all forms of life depend upon each other. For example:

Some plants depend upon bees to pollinate them, and bees depend upon plants for their nectar.

We depend on the electric company to furnish electricity; the electric company depends on us for payment.

Some fish depend on plankton for their food; plankton, in turn, depends on fish for carbon dioxide, its food.

The moon depends on the earth to keep it in orbit; the earth depends on the moon for tidal action.

A classroom contains many examples of interdependence. You depend on your teacher for learning; your teacher depends on you and your classmates to be in school each morning. The next time you raise your hand to answer a question, you will provide an example of interaction.

At the ESA site, you will find many examples of interdependence and interaction among living and nonliving things. One animal eating another—such as a bird eating a worm—is interaction and interdependence. Without available food, the animal eating might well starve; at the same time, he prevents the type of organism he is eating from becoming too numerous.

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How do trees interact with you? How are you and trees interdependent? Did you know that trees transform the carbon dioxide you exhale into oxygen? What are some other examples of interaction and interdependence?

The strand of Interaction and Interdependence occurs in nature and in everything else we do. Think of the town in which you live. The store owners depend on your interaction with them, and you depend on the store owners to furnish the food and goods you need. Interaction and interdependence keep things in balance. When these forces are altered, it results in temporary imbalances, for which nature compensates in ways that often appear chaotic to human beings. What are examples of such temporary imbalances?

ART

Lesson Suggestions

On the site the student can participate in a creative arts lesson that encourages him to wander at will, observe on impulse, and contemplate at length.

Such a lesson can illustrate the principle of interaction between inspiration from the environment and an artist's work of art about his surroundings. An examination of how artists depend on their environment for materials and how the environment depends upon artistic and creative ideas for improvement will give the student a deeper awareness of and appreciation for his surroundings.

Questions for Student Discussion

Man uses his environment in the creation of art—as subject matter and as material. He uses the sun as a character in stories and songs and as a reflector for sculpture and fountains; flowers provide the subjects for myths and material for artistic arrangements; man sings of trees and uses wood instruments to play the music. What on this site

could an artist use for inspiration? What materials on this site could be used to produce art objects?

Can you think of ways that art and the environment interact? What media simply report the environment? What media actually shape the environment? Can you think of any that do both?

COMMUNICATIONS

Lesson Suggestions

The students can do a lesson that clarifies how language and perception are allied. They can interpret situations on the site, translating "signals" from the animate and inanimate objects into verbal or written communication.

The on-site experience can provide countless exercises in trying to put into words what the many things in the surroundings are trying to "say." Even inanimate nature may, in this sense, be delivering a message. We often speak of a "proud" cliff or an "angry" cloud.

The post-site lesson can be an exploration of the many messages an endangered environment is sending to us.

Questions for Student Discussion

With the advent of human beings on this earth, nature acquired a voice, and a mind that can think about itself. But we must be sensitive and careful in our interactions with nature so that our interpretations are accurate. For example, how accurately can you interpret your pet's wishes? Do you have a "green thumb" in relation to plants (a fine ability to sense what botanical life needs and wants)? Are some people more in tune with the environment than others? Why?

What conditions on the site tell about the interactions of the air, the earth, the water, and plant and animal populations?

Are there examples of water pollution or overuse of land or other resources on the site which you can translate into a need for action?

MATHEMATICS

Lesson Suggestions

A mathematical notation—ratios, for example—

can highlight environmental interactions with amazing clarity. Environmental ratios that deal with the number of people as compared with the number of productive land acres or the number of tons of available food can measure the balance between animal (including human) and plant life.

The students can calculate relevant findings about the amount of land to the amount of water at a given site or the acres of grassland to the acres of woodland using fractions, percent computations, and more complicated algebraic treatments. Whatever the choice of numerical subject matter, the environment will prove to be a most meaningful source of numbers in relation to the student's life.

Questions for Student Discussion

How many animals and what kinds of animals can interact with an environment for a given time without decimating that environment?

What considerations do planners give to ratios of people to air, water, and earth in establishing or renewing urban areas?

What percentage of air must be composed of foreign materials before it is considered polluted?

What percentage of water must have foreign elements in it before it is considered polluted?

How can you measure environmental interactions?

SCIENCE

Lesson Suggestions

In the on-site lesson, the student can observe the difference between interaction and interdependence. When a bird alights on a tree, it is an instance of interaction. When the bird eats the tiny insects that subsist on the leaves of the tree, it is an instance of interdependence. The tree harbors certain organisms that the bird can eat, thereby surviving. By devouring these organisms, the bird in turn helps to protect the tree.

The student can also focus on broader interactions and interdependencies, such as those triggered by seasonal changes (a riverbed depending on the spring thaw to melt the snow so that the river can flow and irrigate the land). Such observations illustrate the ways in which nature's cyclic processes operate interdependently.

Lessons on interaction may be as simple as the observation of leaves turning toward the sun or as complicated as a study of plant auxins biochemically regulating plant growth.

SOCIAL STUDIES

Questions for Student Discussion

How has man interacted with water to change his environment?

How has man used the air to change his environment?

How does the moon affect the earth's environment?

How does the sun affect the earth's environment?

What physical forces are interacting on the site right now?

How does each object on the site interact with its environment?

What things on the site has man made out of raw materials?

What natural laws govern interactions among the air, water, earth, and other populations on this site?

What scientific (technological) inventions have had detrimental or beneficial effects on this site?

Could man improve this site? How?

Lesson Suggestions

In the pre-site lesson, students can explore how individuals stand in relation to groups—how, in small groups, the individual can assume a greater number of roles; how, in larger groups, the individual has a more generalized function, such as voting.

On the site, the students can note how the various animal populations are interrelated and interdependent with the food chain, or how individual members of groups assume specialized functions for the protection and efficiency of the group (worker and drone bees, male bird gathering food while mate is nesting, etc.).

The post-site lesson can show how new groups are formed in our society to bring about social change and reform. This lesson can present to the students the many different kinds of groups that have been formed to solve ecological problems, from the small neighborhood anti-litter groups to national environmental study groups set up by presidential initiative.

Questions for Student Discussion

How has man tried to assert his dominance over his environment?

What natural resources are involved in agricultural developments? economic developments? political? technological?

How does man use mountains as a natural resource? deserts? water? earth? air?

How does a search for gold, riches, and adventure work for or against conservation of natural resources? What are some historical examples?

How did populations use this site previously? Where did the water come from? How did they get their food? What kinds of homes did they make?

Has population growth had any impact on this area? What? With what effect?

What government agency is responsible for regulating the use of this area?

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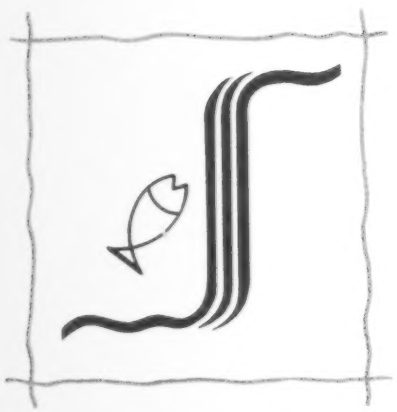


CONTINUITY & CHANGE

Introducing Continuity and Change to Students

There is an old French proverb that says, "The more things change, the more they remain the same." That is the story of Continuity and Change. Animals are born, live awhile, and die, and young animals take their place. Flowers bloom, fade, and become part of the soil. Water evaporates, forms clouds, snows, becomes water, and irrigates the earth. Such is the continuity of life on earth. Things may change, but they always continue on in some form or fashion.

Everything on the earth is part of a continuing cycle of change: oceans, lakes, and rivers change; the rocks change; the weather changes; animals and plants change; even you change. Nothing really stands still.

Your life is a continuity, and your life is a series of changes. Do you get bored because your day-to-day experiences never change? Your daily schedule is a continuity because everything continues evenly and undisturbed. But once in a while changes occur that break the daily stream of events. Your trip to the site will be a change (but at the same time will there be a continuity of events?).

Nature is much the same way. Clouds go streaming across the sky, disappear below the horizon, and return eventually with their life-saving rain. Thus weather is a continuity over a period of time, yet we speak casually about changes in the weather.

Look for changes and activity in nature, in your surroundings. What changes will there be in a day or a month or a year—in a particular spot? in your home? in you?

ART

Lesson Suggestions

One lesson might illustrate for the student how—though artistic styles have changed through the years—the environment remains a constant theme.

An on-site lesson can direct the student to observe the everyday changes occurring within the framework of constant environmental processes while he examines what a painter, dancer, composer, or other artist must do to capture these changes.

Post-site study can be directed toward an examination of how both the environment and artistic representations of it have constantly influenced the inner man—moving, shifting, ever in transition, but always mirroring, deepening, and changing man's feelings of beauty, pathos, and harmony.

Questions for Student Discussion

How does man's art change as his environment changes?

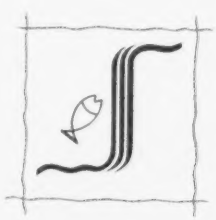
What materials from the environment has man changed to produce art?

Do ideas about art change as environmental values change?

Do natural resources ever become landmarks? Why do they get this attention?

Dance, music, poetry, painting—all these art forms can express the movement and change of the environment. Which art form would best express the flow of this site?

How can music played on the site change your mood?



COMMUNICATIONS

Lesson Suggestions

The pre-site lesson can explore how man, on receiving messages from an endangered environment, makes changes to bring ecological imbalances back into normal order and continuity. What kinds of messages must we receive in order to make our

changes most intelligent? Surely we ought to read as much as we can and consult with as many experts as possible. What sources of information are available?

On the site the students can examine environmental needs specific to the area and discuss appropriate sources of information that would adequately guide and inform those who could institute the necessary changes.

The post-site lesson can be a class activity in which the students, functioning as a committee, prepare a report to an appropriate city official, detailing the environmental needs of the community, the informational resources available, and suggestions for change and continuity.

Questions for Student Discussion

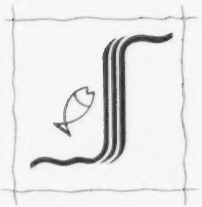
What human communication might have been heard 300 years ago on this site?

What communication can you now hear that you could not have heard 300 years ago?

What does the presence or absence of people, animals, and plants tell you about how this site has changed?

Can you tell from the conditions in a given locality at a given time what season it is?

What feelings are communicated by a change in the season?



MATHEMATICS

Lesson Suggestions

Because it is often difficult to see spectacular changes on the site, students may wonder if things simply exist from day to day, continuing to be just as they are. Graphing, even by very young students, is a technique that can show change relationships. Measuring and plotting, for example, the height of plants over a span of time will produce a clear illustration of a growth curve.

Other graphing lessons can deal with urban growth and the relationships of populations to housing. Many human environments, such as the classroom itself, will provide evidence of change as one plots and graphs the various characteristics of the changing student population.

In higher mathematics, the use of proportions can show how changing one element of the environment changes the numerical relationships of other environmental factors as well. The lessons suggested here can start with on-site measures and counts, which will whet the students' interest in the outcome of their calculations.

CONTINUITY & CHANGE

Questions for Student Discussion

What changes do you see when you plot growth curves of plants? populations? urban centers?

Calculate how many people can be accommodated in your community, considering requirements of air, earth, and water. What changes would be made by an increase in population? How can such changes be measured?

Remove one environmental factor at a time (some large, some small). Consider the magnitude of changes in the total environment that results from removing each factor.

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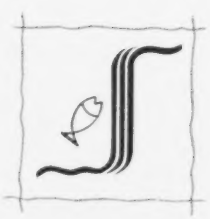

SCIENCE

Lesson Suggestions

In the pre-site lesson, the students can consider objects in the classroom as they have changed over time. What materials constitute their desks? How have they been changed to create the finished product? How were desks different 100 years ago?

On the site, students can identify the raw materials used to produce objects with which they are familiar in daily life—trees for lumber, minerals from rocks or mines for nails and bolts, and so forth. They can observe that objects may undergo many changes but still retain their primary qualities. A tree may be bare in winter, bud in spring, bloom in summer, and lose its foliage in fall, but there is a basic continuity to these processes that permits the tree to continue living and undergoing changes.

In the post-site lesson, the students can further explore links between the objects around them and those found in nature. When their desks are no longer functional, perhaps they will be used for firewood, their ashes becoming part of the soil from which trees will continue to grow. All cycles—water, nitrogen, sugar, metabolism—are illustrations of change and continuity.

Questions for Student Discussion

How does water change?

How does the air change?

How does the earth change?

How does a change of season affect this area?

Have scientific discoveries changed this site in any way? How?

Has man made any changes on this site? How?

Have there been changes you consider good on this site?

Have some changes had a negative effect?

What conditions have continued?

SOCIAL STUDIES

Lesson Suggestions

The pre-site lesson can focus on differences between our social environment today and at a fixed time in the past. A strong contrast can be drawn between social attitudes toward conservation and pollution today and those that prevailed in this country at the turn of the century, when only a handful of dedicated men, such as John Muir and Theodore Roosevelt, fought against ruthless and reckless exploitation of our national resources. Today, of course, our environmental problems are more drastic, but the social groups coping with these problems are greater in number too. Social attitudes *do* change.

The on-site experience can be an exploration of society's attitudinal change toward the environment. What material changes made on the site since 1900 show such change?

The post-site lesson can be directed to the question, "What means are necessary to change social attitudes?"

CONTINUITY & CHANGE

Questions for Student Discussion

What life cycles are evident on this site?

Have the communities of plants, animals, and people changed? Has the entire area changed?

Has the territory belonging to animals changed? Has the territory belonging to people changed?

Has the value of the area changed? Why?

Has agriculture or industry changed this area? How?

What changes in the environment, brought about by people, are beneficial to the environment? What changes are detrimental?

What changes in this environment, brought about by people, are beneficial to other people? What changes are detrimental?

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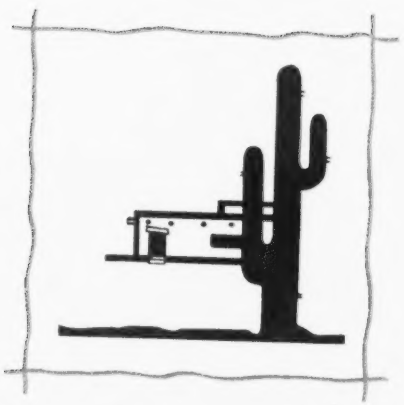


EVOLUTION & ADAPTATION

Introducing Evolution and Adaptation to Students

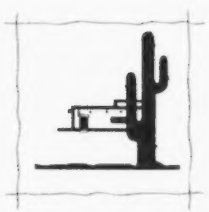
Evolution is a slow process by which organisms physically change. The change may take thousands or millions of years. For example, the horse started out as an 11-inch, four-toed creature. Today it is a one-toed animal standing about five feet high. It has also evolved huge upper molars, enabling it to graze on prairie grass.

An animal or plant may evolve, but if it does not adapt or fit into an environment, it dies. Adaptation is the successful interaction of an organism with its environment. Some organisms have been unsuccessful: dinosaurs didn't make it, but bees did; mammoths didn't make it, but tigers did; most coelacanths couldn't make it, but oak trees and man could. They evolved to adapt and adapted to evolve.

Man uses technology to adapt to his environment. He opens a thermos or goes to a faucet when he is thirsty. The camel and the cactus store water. Most animals have to find it—at water holes, in the roots of plants, or in fruits and vegetables. Think of other living things. What special kinds of structures do they have which enable them to fit into their surroundings?

As a human being, how have you adapted to your environment? There is a direct relationship between how you adapt to your environment and the pattern in which you live. The way that you have developed and how you fit into your surroundings is a very definite measure of how successfully you can interact with your environment. The development of your interdependence with your fellow creatures is part of your adaptation to your environment.

Can you now begin to see how all the strands apply to all the environment and relate to each other as well?



ART

Lesson Suggestions

Art lessons in Evolution and Adaptation can clarify for students how man has adapted his creative ideas to his surroundings and evolved art works that reflect and fit his environment. Modern architecture and outdoor sculpture are just two examples.

An on-site lesson can examine any number of ways the environment could evolve through artistic adaptations. In pre- and post-site lessons, students can study how artists have treated evolution and adaptation in the environment. Charlie Russell, the famous cowboy artist from Montana, depicted the Old West as it evolved from the days of the stagecoach to the era of the railroads and airplane. Many artists have revealed their feelings as they lived through the evolution of the landscape and adapted with the environment. These testaments and the works of these artists can be the basis for a number of lesson plans.

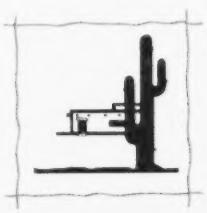
Questions for Student Discussion

How has man's decoration of his body and his home evolved from the past to the present as an art form?

What different art forms have evolved with man's technology? What evidence of those art forms or that technology can be seen on this site?

How is architecture an adaptation of art found in the environment? How has the environment evolved through architecture?

How have architecture and creative planning adapted this site to satisfy your needs and desires?



COMMUNICATIONS

Lesson Suggestions

In the pre-site lesson, the class can study how the English language has evolved through the centuries, from a rough-and-ready Saxon tongue with a small vocabulary to a world language with a lexicon of 13 huge volumes (Oxford English Dictionary).

Adapting to this language is one of the major tasks of the schoolchild. What are the principal

difficulties in such an adaptation—learning the huge vocabulary? writing grammatically? learning to speak effectively?

The on-site experience can be a vocabulary-building exercise, learning the names of things found at the site.

The post-site lesson can be thematically built around the rapid change our language has undergone within the last 50 years. A close study of a page of any newspaper will quickly reveal words that were not in the lexicon 50 years ago. Adapting to language is a day-to-day process.

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Questions for Student Discussion

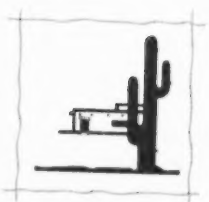
What kinds of communication are best adapted to presenting environmental conditions to the public?

What can you tell about the adaptation of this site for its present use? future use?

How can you evolve a better understanding of this site in order to communicate your feelings about it?

How will this spot evolve? How can your ability to communicate effect changes on this spot (natural or man-made) for future generations?

What new kinds of communication systems can be evolved to signal man that the environment is in danger?



MATHEMATICS

Lesson Suggestions

Perhaps no other method of communication has changed the environment to such a degree as mathematics. Man's advanced technology, resulting in the automation and computerization of industry and providing man with the ability to find out what is happening to the environment in split seconds, has changed and evolved the social, political, and economic structure of the earth.

Man continually needs to adapt to his own inventions and changes. The evolution of his technology will become more and more pronounced. Students at all maturity levels can learn to fit more easily into their world if they are aware of this process. Lesson objectives should lead to basic understandings of how today's computers rapidly calculate numerical relationships and how these calculations affect the environment and help people live more comfortable lives.

Predicting weather, keeping records, and operating such complicated experiments as putting satellites into orbit are examples of computer use which

can be translated into functional math lessons. The computer mathematics that describes today's environment and the students' future environment provides material for pragmatic lessons.

Questions for Student Discussion

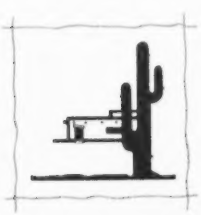
What percentage of your city has been adapted for use by the automobile?

Has automation changed the on-site environment?

Has the invention of new technologies played a role in the evolution of the environment? For example, in what ways has the wheel changed man's environment?

Could you adapt to a world without numbers?

What role does statistics—the mathematics of chance and probability—play in understanding biological evolution?



SCIENCE

Lesson Suggestions

On the site, the student can observe the ways in which the objects he sees have adapted themselves to their environment. Through the process of evolution, many animals have adapted to cold climates by developing heavy fur coats that cover layers of stored fat to sustain them during the long winter months when food is scarce. The student can recognize that he himself has probably taken steps to adapt to this environment by using his intelligence and technology. Perhaps he has put on a warm coat or hiking shoes. Without such efforts at accommodation, he might not feel at all comfortable at the site.

Through the ages organisms that have not evolved the means to adapt to their surroundings have not fared well. Most have died out. The student can regard the majority of objects he sees on the site as successful examples of adaptation to a given setting. He can then consider what kinds of adaptation will be necessary in the future so that these objects can exist in environments being changed by man, as in the case of a highway being built through a forest. Can the slow process of evolution permit the necessary adaptations to take place in time for the organisms to survive?

More advanced classes may discuss the theories of evolution and the ways in which molecules direct hereditary continuity and change.

Questions for Student Discussion

How has this site evolved into its present state?

How has it changed in appearance since prehistoric times?

What kinds of prehistoric animals lived here?

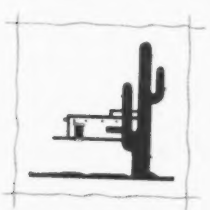
Why did some animals become extinct from this area?

How do animals adapt to seasonal changes at this site?

How have organisms here adapted to this site?

Which will continue to adapt? Are there some objects that will not evolve—that are in danger of becoming extinct? Why?

What are some of the successes man has enjoyed in trying to control his environment? What are some of the failures?



SOCIAL STUDIES

Lesson Suggestions

Individuals adapt to social groups by assuming certain roles within the group, but it is wise to adapt in a flexible manner. Groups continually change in their composition, function, and purpose and require their members continually to adapt to these shifting conditions.

The pre-site lessons can explore how each individual in the class has adapted to the conditions of the social group that is the class and how he and his classmates are constantly adapting to changing conditions. For example, how is the class preparing for the on-site visit? What communal activities and what roles are necessary for this preparation?

On the site, the student can study his own class and observe how the group changes to fit the new surroundings. For example, have seating arrangements changed? Has the teacher's role changed?

After the site visit, the student can assess the change that has occurred in the group (in attitude, etc.) and his own adaptation to that change.

Questions for Student Discussion

What evidence on the site shows man's attempts to adapt the area to his needs?

How was this place used in the past? How will it be used in the future?

If you were going to live here, how would you get your food, clothing, shelter, water?

Do you think this area should be made into a housing development? Why? Why not?

How has the class adapted to the on-site experience?

What new attitudes have evolved because of the lessons?

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FILMS

The American Island. 27½ min. Outdoor recreation and open space opportunities available on islands off the coasts, in the lakes, and in the rivers. Bureau of Outdoor Recreation, Department of the Interior, Washington, D.C. 20240.

The American Trail. 27½ min. Walking, hiking, bicycling, and other trails which offer many Americans their chief association with the outdoors. Bureau of Outdoor Recreation, Department of the Interior, Washington, D.C. 20240.

An Approach to School Site Development. 19 min., 16mm, sound, color. International Film Bureau, 332 S. Michigan Ave., Chicago, Ill. 60604.

Art for Tomorrow. 30 min. Art's response to an increasingly technological environment: cybernetic art, computer art, and other forms. McGraw-Hill, 330 W. 42nd St., New York City 10036.

A Child Went Forth. 45 min. The diverse effects of various educational environments on youngsters. American Institute of Architects, 1735 New York Ave., N.W., Washington, D.C. 20006.

Environmental Awareness. 5½ min. Finger painting is used to present a dramatic, off-beat view of environmental pollution effects. National Park Service, Washington, D.C. 20240.

Four-Day Week. 25 min. The environmental implications of the increasing leisure time available to Americans. Slightly dated, still valid. McGraw-Hill, 330 W. 42nd St., New York City 10036.

Games Futurists Play. 30 min. The novel planning technique of "gaming" as explored in an imagined San Diego situation. McGraw-Hill, 330 W. 42nd St., New York City 10036.

The House of Man—Our Crowded Environment. 11 min. Encyclopaedia Britannica Films, 425 N. Michigan Ave., Chicago, Illinois 60611.

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How Will We Know It's Us? 27½ min. A plea for enough preservation to maintain our historical perspectives in a society where progress and change are equated. Modern Talking Picture Services, Inc., 1212 Avenue of the Americas, New York City 10036.

Images. 6 min. The cameraman finds intriguing and beautiful patterns in modern structures and devices in the urban environment. Sterling Films, 43 W. 61st St., New York City 10023.

In Search of Space. 27½ min. Outdoor recreation space needs in the urban environment. Bureau of Outdoor Recreation, Department of the Interior, Washington, D.C. 20240.

Multiply—and Subdue the Earth. 60 min. The principle of total ecological planning applied to problems such as who should decide and how do we decide where residential developments should be located. Indiana University Audio-Visual Center, Indiana University, Bloomington, Indiana 47401.

Noise—the New Pollutant. 30 min. Compares hearing ability of Americans bombarded with their daily noise rations and the acute hearing of remote African peoples. Indiana University Audio-Visual Center, Indiana University, Bloomington, Indiana 47401.

The Noisy Landscape. 12 min. Concerns visual pollution, the "shouting" of signs and billboards, the need for restrained graphics in our urban environment. Sterling Films, 43 W. 61st St., New York City 10023.

Our Poisoned World. 25 min. Concentrates principally on DDT and the chlorinated hydrocarbons, WOOD-TV, 120 College Ave., S.E., Grand Rapids, Michigan 49502.

Outdoor Education. 28½ min. How the school curriculum can be extended and enriched through the use of outdoor resources and by teaching attitudes, skills, and appreciations necessary for satisfying outdoor interests and pursuits. AAHPER, 1201 16th St., N.W., Washington, D.C. 20036.

Pollution. 3 min. Tom Lehrer's song as illustrated by a young filmmaker. USC Film Division, University Park, Los Angeles, California 90007.

The Proper Place. 8 min. A cartoon history of the packaging industry and consequent solid waste environmental problems. Association Films, 600 Madison Ave., New York City 10022.

The Recreation Imperative. 7½ min. Key elements of a long-range nationwide outdoor recreation plan. Bureau of Outdoor Recreation, Department of the Interior, Washington, D.C. 20240.

The Searching Eye. 17 min. Stresses need to contemplate and understand our surroundings. Pyramid Films, Box 1048, Santa Monica, California 90406.

Sense of Wonder. 60 min. Environmentalist themes from author Rachel Carson and photographer Ansel Adams. McGraw-Hill, 330 W. 42nd St., New York City 10036.

Silent Spring. 60 min. The Rachel Carson classic which may well be the key document of the age of the Environment. McGraw-Hill, 330 W. 42nd St., New York City 10036.

Tall as the Mountains. 27½ min. Urban youth confronted with survival in the Colorado wilderness, and how they cope. Adolph Coors Company, Golden, Colorado 80401.

What Are We Doing to Our World? 25 min. Air, water, pesticide, radiation, thermal, auto, and aircraft pollution. McGraw-Hill, 330 W. 42nd St., New York City 10036.